Steel Manufacturing

(SIC 331)

SIGNIFICANT POINTS

- Employment is expected to continue to decline.
- Much steel production has shifted to the electric arc furnace, changing many jobs and enhancing opportunities for individuals with technical skills and training.

Nature of the Industry

Few industries in the United States have changed as rapidly in recent years as the steel industry. As a result of new investment in equipment and worker training, this industry has gone from a seemingly moribund one, to one that leads the world in worker productivity and is the low cost producer for some types of steel. The U.S. steel industry still faces stiff competition, and employment is expected to continue to decline; but it is now in a more promising position to meet these challenges.

With new investments have come fundamental changes in the nature of this industry. The most significant change in the American steel industry is the development of the electric arc furnace (EAF), sometimes called the "minimill," which converts scrap metal from many sources—such as bridges, refrigerators, and automobiles—to steel. The term "minimill" originated from the relatively smaller size of these mills when they first appeared, compared with traditional integrated mills. Today, many EAF's or minimills are actually larger than integrated mills producing steel from raw materials. The smaller capital outlay required to start and operate an EAF has helped drive its growth. Moreover, scrap metal is found in all parts of the country, so EAF's are not tied as closely to raw material deposits as integrated mills and can locate closer to consumers. EAF's now comprise almost half of American steel production and their share is expected to continue to grow in coming years.

The growth of EAF's comes partly at the expense of integrated mills. Integrated mills produce iron in blast furnaces, from coal, iron ore, and limestone. The iron is then refined into steel, most commonly in basic oxygen furnaces. The steel produced by integrated mills generally is considered to be of higher quality than steel from EAF's, but because more steps are involved in the production process, it also is more costly. The initial step in the integrated mill process is to prepare coal for use in a blast furnace by converting it to coke. Coal is heated in coke ovens to remove impurities and to reduce it to nearly pure carbon. Because coke production is considered to be one of the dirtiest steps in production, many firms are looking for substitutes for coke in steelmaking.

At the other end of the steel manufacturing process, semifinished steel from either EAF's or integrated mills is converted into finished products. Some of the goods produced in finishing mills are steel wire, pipe, bars, rods, and sheets. Products also may be coated with chemicals, paints, or other metals that give the steel desired characteristics for various industries and consumers. Also involved in steel manufacturing are firms that produce alloys, by adding materials like silicon and manganese to the steel. Varying the amounts of carbon and other elements contained in the final product can produce thousands of different types of steel, each with specific properties suited for a particular use.

Increasing competition from abroad and in the domestic market has caused integrated and EAF producers to modernize. For workers, this often has meant learning new skills to operate sophisticated equipment. Competition also has resulted in increasing specialization of steel production, as various producers attempt to capture different niches in the market. With these changes has come a growing emphasis on flexibility and adaptability for both workers and equipment. As international and domestic competition mounts for U.S. steel producers, the nature of the industry is expected to continue to change in these directions.

Working Conditions

Steel mills evoke images of strenuous, hot, and potentially dangerous work. While many dangerous and difficult jobs remain in the steel industry, modern equipment and facilities have helped to change this. The most strenuous tasks were among the first to be automated. For example, computer-controlled machinery helps to monitor and move iron and steel through the production processes, reducing the need for heavy labor. In some cases, workers now monitor and control the equipment from air-conditioned rooms.

Nevertheless, large machinery and molten metal can be hazardous, unless safety procedures are observed. Hard hats, safety shoes, protective glasses, ear plugs, and protective clothing are required in most production areas.

The expense of plant and machinery and significant production startup costs force most mills to operate around the clock. Workers averaged 44.6 hours per week in 1998, and only about 1.7 percent of workers are employed part time. Night and weekend shifts are common, as is overtime work during peak production periods. In 1998, 33.7 percent of all steel workers put in overtime.

Cases of occupational injury and illness in the industry were 12.0 per 100 full-time workers in 1997, significantly higher than the 7.1 cases per 100 workers for the entire private sector and also higher than the 10.3 cases per 100 for all manufacturing. The highest injury rate in the steel industry—16.3—was found in steel pipes and tubes.

Employment

Employment in the steel industry declined to about 232,000 wage and salary jobs in 1998, less than half its 1980 level. The rate of decline, however, has slowed in recent years. The steel industry traditionally has been located in the eastern and midwestern regions of the country, where iron ore, coal, or one of the other natural resources required for steel are found. Even today, about 50 percent of all steelworkers are employed in Pennsylvania, Ohio, and Indiana. The growth of EAF's, though, has allowed steel-making to spread to virtually all parts of the country. Large firms employ most workers in the steel industry. Over 9 out of 10 work in establishments employing at least 50 workers, and almost half work in establishments employing 1,000 or more persons (chart 1).

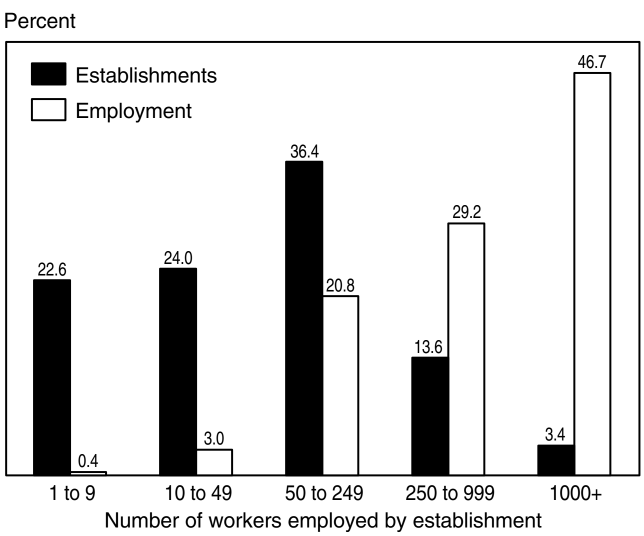
Occupations in the Industry

Opportunities exist in a variety of occupations, but the majority of workers—79 percent—are employed in operator, fabricator, and laborer and precision production, craft, and repair occupations (table 1). About 17 percent work in managerial, professional, and administrative support occupations.

At an integrated steel mill, production begins when *material moving equipment operators* load iron ore, coke, and limestone into the top of a blast furnace. As the materials are heated, a chemical reaction frees the iron from other elements in the ore. *Blowers* direct the overall operation of the blast furnace. *Blowers* are responsible for the quality and quantity of the iron produced and for supervising *keepers* and their helpers. *Keepers* operate the equipment used to tap the liquid iron and to remove impurities from the furnace. The molten iron then is ready to be transformed into steel.

Generally, either a basic oxygen or an electric arc furnace is used to make steel. Although the steel making procedure varies with the type of furnace used, the jobs associated with the various processes are similar. *Melters* supervise *furnace operators* and their assistants who control the furnace. *Melters* gather information on the characteristics of the raw materials they will use and the type and quality of steel they are expected to produce. They direct the loading of the furnace with raw materials and supervise the taking of samples, to insure that the steel has the desired qualities. *Melters* also coordinate the loading and melting of raw materials with the steel molding or casting operation to avoid delays in production.

Almost half of all steel workers are employed in establishments with 1,000 or more workers



Source: U.S. Department of Commerce, *County Business Patterns*, 1997

Furnace operators use controls to tilt the furnace to receive the raw materials. Once they have righted the furnace, *furnace operators* use levers and buttons to control the flow of oxygen and other materials into the furnace. During the production process, assistants routinely take samples to be analyzed. Based on this analysis, *operators* determine how much longer they must process the steel or what materials they must add to meet specifications. *Operators* also pay close attention to conditions within the furnace and correct any problems that arise during the production process.

Traditionally, liquid steel was moved from the furnaces into a ladle from which it was poured into ingots. Steel producers now use a process known as "continuous casting" almost exclusively. Continuous casting allows firms to produce steel ready for the next step in processing directly from liquid steel, thus eliminating many of the steps involved in pouring and rolling ingots. *Molding* and *casting machine operators* tend machines that release the molten steel from the ladle into water-cooled molds at a controlled rate. Molded steel is then cut to desired lengths, as it emerges from the rolls. During this process, operators monitor the flow of raw steel and the supply of water to the mold.

The "rolling" method shapes most steel processed in steel mills. In this method, hot steel is squeezed between two cylinders or "rollers," which flatten or shape the steel. *Heaters* monitor equipment that tells when the ingot is uniformly heated to the required temperature. *Rollers* operate equipment that rolls the steel ingots into semifinished product; the quality of the product and the speed at which the ingot is rolled depend on the roller's skills. *Manipulator operators* tend the machinery, which controls the position of the ingot on the roller. Placing the ingot and positioning the rollers are very important, for they control the product's final shape. Improperly adjusted equipment may damage the rollers or gears.

Millwrights are employed to install and maintain much of the sophisticated machinery in steel mills. As the technology becomes more advanced, they work more closely with *electricians*, who help repair and install electrical equipment like computer controls for machine tools.

With more sophisticated technology and demands for specialized products, *scientists*, *engineers*, and *technicians* have a significant role in the steel industry. For example, *engineers* test batches of steel before they are cast, to check for the desired composition. They also may develop new specialized metals as well as new equipment. As in other industries, there also are many managerial and administrative support jobs.

Training and Advancement

As machinery becomes more complex, employers increasingly prefer to hire college graduates for highly skilled operating positions. For some production positions, vocational or community college training may be required.

Once production workers are hired, they receive training on the job. New workers entering the production process as lower-skilled laborers generally assist more experienced workers, beginning with relatively simple tasks. As workers acquire experience, they specialize in a particular process and acquire greater skill in that area. They may progress from second helper to first helper, and then to a skilled position, such as melter or roller. The time required to become a skilled worker depends upon individual abilities, acquired skills, and available job openings. It generally takes at least 4 or 5 years, and sometimes much longer, to advance to a skilled position. At times, workers change their specialization to increase their opportunities for advancement. Especially in EAF's, workers are trained to perform a variety of tasks and provide more flexibility to the firm, as company needs change.

Table 1. Employment of wage and salary workers in steel manufacturing by occupation, 1998 and projected change, 1998-2008

(Employment in thousands)

Occupation	1998 Employment Number	1998 Employment Percent	1998-2008 Percent change
All occupations	232	100.0	-23.7
Operators, fabricators, and laborers	112	48.6	-21.2
Machine tool cutting and forming setters, operators, and tenders, metal and plastic	24	10.4	-13.8
Helpers, laborers, and material movers, hand	18	7.8	-26.8
Other machine setters, operators, and tenders	11	4.8	-20.8
Crane and tower operators	10	4.3	-23.6
All other assemblers, fabricators, and hand workers	9	4.0	-23.6
All other metal and plastic machine setters, operators and related workers	8	3.2	-23.6
Furnace operators and tenders	6	2.4	-16.0
Industrial truck and tractor operators	5	2.1	-23.6
Welders and cutters	4	1.6	-31.3
Heat treating machine operators and tenders	3	1.5	-23.6
Metal fabricating machine operators	3	1.2	-20.9
Precision production, craft, and repair	70	30.0	-26.6
Blue collar worker supervisors	16	7.0	-23.6
Industrial machinery mechanics	11	4.9	-21.4
Inspectors, testers, and graders, precision	6	2.7	-33.8
Electricians	9	3.7	-23.6
Millwrights	5	2.1	-51.5
Maintenance repairers, general utility	3	1.5	-30.6
Machinists	3	1.3	-23.6
Administrative support, including clerical	16	6.9	-30.4
Other clerical and administrative support workers	3	1.5	-25.3
Shipping, receiving, and traffic clerks	2	1.0	-29.8
Financial records processing occupations	2	0.9	-36.6
Executive, administrative, and managerial	15	6.3	-24.9
Management support occupations	5	2.1	-24.9
Industrial production managers	3	1.2	-25.8
General managers and top executives	2	1.0	-25.9
Professional specialty	9	3.7	-13.8
Engineers	5	2.3	-19.2
Technicians and related support	3	1.4	-29.0
Engineering and science technicians and technologists	3	1.2	-27.9
Marketing and sales	4	1.9	-23.6
Service	3	1.2	-29.5

Computers have become important, as companies have modernized. Workers must learn to operate computers and other advanced equipment. Although much of the specific training is done on the job, employers prefer to hire applicants who have completed formal classroom training in a technical school or college.

To work as an engineer, scientist, or in some other technical occupation in the steel industry, a college education is necessary. Many workers in administrative and managerial occupations have degrees in business or possess a combination of technical and business degrees. A master's degree may give an applicant an advantage in getting hired or help an employee advance.

Earnings

Earnings in the steel industry vary by occupation and experience but are higher than average earnings in private industry. Average weekly earnings of nonsupervisory production workers in 1998 were $822 in the steel industry, compared to $563 in all manufacturing and $442 throughout private industry. Weekly earnings in blast furnaces and steel mills, at $907, were significantly higher than those in steel pipes and tubes, at $626. Earnings in selected occupations in steel manufacturing appear in table 2.

Table 2. Median hourly earnings of the largest occupations in steel manufacturing, 1997

Occupation	Steel manufacturing	All industries
First line supervisors and managers/ supervisors-production and operating workers	$20.05	$16.62
Electricians	17.42	16.54
Machinery maintenance mechanics	17.16	14.72
Millwrights	15.88	16.99
Crane and tower operators	14.89	14.04
Furnace operators and tenders	14.89	11.88
Rolling machine setters and set-up operators, metal and plastic	14.35	12.52
Industrial truck and tractor operators	13.73	10.99
Production inspectors, testers, graders, sorters, samplers, and weighers	12.60	10.15
Machine forming operators and tenders, metal and plastic	11.69	9.55

Union membership, geographic location, and plant size affect earnings and benefits of workers. In some firms, earnings or bonuses are linked to output. Workers receive standard benefits, including health insurance, paid vacation, and pension plans.

The iron and steel industry traditionally has been highly unionized. In 1998, 44.3 percent of steel workers were covered by union contracts, compared with 16.8 percent in all of manufacturing and 15.4 percent in all industries. In some instances, companies are closed shops; that is, workers must belong to the union, in order to work there. EAF's, though, typically are non-union. The overall decline of employment in traditional integrated steel mills and the growth of EAF's, together, have caused union membership to decline in recent years.

Outlook

Employment in the steel industry is expected to decline by about 24 percent over the 1998-2008 period. This decline can mostly be attributed to increased use of labor-saving technologies and machinery. Other factors affecting employment in the industry include foreign trade, overall economic conditions, the growth of EAF's, and environmental regulations. Despite the continuing decline in employment, qualified workers still will be needed to replace workers who retire or leave the industry. Opportunities will be best for individuals with the technical skills and training to handle technologically advanced machinery.

Employment levels in coming years will be greatly affected by the ability of steel makers located in the United States to compete with imports from abroad. Worker productivity has increased in U.S. firms in recent years, leaving the domestic steel industry better able to compete with imports. Many American steel producers, however, complain that they face unfair competition from abroad and that foreign producers, subsidized by their governments, are "dumping" steel in the U.S. market. Efforts currently are underway to improve trade relations in steel. If these efforts are successful, increasing trade would almost certainly result, which would foster growth in the most efficient American firms as they take advantages of growing export opportunities. It also would hasten the demise of inefficient plants trying to compete with low-priced imports.

Employment in the steel industry varies with overall economic conditions and the demand for goods produced with steel. For example, as the automotive industry produces more cars and light trucks, it will purchase more steel. In this way, much of the demand for steel is derived from the demand for other products. Other industries that are significant users of steel include structural metal products, motor vehicle parts and equipment, and household appliances. As many of these goods require a large outlay, consumers are more likely to purchase them in good economic times.

Steel companies, like most businesses, have entered the era of sophisticated technology. Taking several forms, this technology has improved both product quality and worker productivity. Computers are essential to most technological advances in steel production, from production scheduling and machine control, to metallurgical analysis. Computerized systems change the nature of many jobs, while they eliminate or reduce the demand for others. For example, computers allow one worker to perform duties that previously took the efforts of several workers. However, computer-controlled equipment often requires operators to have greater skills. Hence, workers who are comfortable with computers and other high-tech equipment—as well as those willing and able to learn—will be more widely sought after by employers. This automation will contribute to better opportunities for engineers and other professional specialty occupations, while causing significant declines for lower-skilled machine operators and inspectors.

Environmental issues also have affected the steel industry. Past decades have seen technological changes spurred by environmental emission regulations. Emission standards, under the present Clean Air Act, will likely result in costly modifications or shutdowns in many coal-processing facilities that employ a dirty, heavily polluting process. Necessary furnace modifications will require major investments and increase the overall cost of production for coke-producing plants. These modifications are, therefore, likely to raise costs in integrated mills that use coke to produce steel.

The emergence of EAF's is perhaps the most important factor in transforming the steel industry. This trend will continue in the foreseeable future, as EAF's dominate the new capacity expected to begin operation in the next few years. Integrated mills are expected to maintain a major share of the market in higher grade steel and are also entering areas like residential construction; but EAF's will continue to account for a larger share of the international steel market. Growth of EAF's is driven by many factors, including relatively low startup costs, flexibility, and the ability to locate close to the consumer. This is especially important in the construction industry. Because the scrap steel they need to operate is widely available, EAF's have provided job opportunities in the steel industry in additional geographic areas. However, since they generally have higher worker productivity, as EAF's capture more of the domestic steel market, fewer workers will be employed to meet the existing demand for steel products.

Sources of Additional Information

For additional information about careers and training in the steel industry, contact:

- American Iron and Steel Institute, 1101 17th St. NW., Suite 1300, Washington, DC 20036-4700.
- Steel Manufacturers Association, 1730 Rhode Island Ave. NW., Suite 907, Washington, DC 20036-3101.

Information on the following occupations may be found in the 2000-01 *Occupational Outlook Handbook*:

- Blue-collar worker supervisors
- Electricians
- Engineers
- Industrial machinery repairers
- Inspectors, testers, and graders
- Machinists and numerical tool and process control programmers
- Material moving equipment operators
- Metalworking and plastics-working machine operators
- Millwrights